DESCRIPTION

EXHAUST SENSOR CONTROL SYSTEM

Technical Field

The present invention relates to an exhaust sensor control system, and more particularly to an exhaust sensor control system for controlling the status of an exhaust sensor that is mounted in an exhaust path to detect the status of an internal combustion engine exhaust gas.

Background Art

In a conventionally known system disclosed, for instance, by Japanese Patent Laid-open No. Hei 4-359142, an oxygen sensor is mounted in an internal combustion engine exhaust path to detect the status of an exhaust gas. The oxygen sensor generates an output in accordance with the oxygen concentration in the exhaust gas after reaching its activity temperature. To this end, the oxygen sensor incorporates a heater, and heated to its activity temperature by the heater while the internal combustion engine is operating.

The exhaust gas contains a large amount of water vapor. Therefore, if the oxygen sensor temperature suddenly drops after an internal combustion engine stop, a large amount of water is adsorbed by a sensor element of the oxygen sensor.

After internal combustion engine startup, the internal combustion engine exhaust sensor is generally heated to a predetermined activity temperature. In such a heating process, the output from the exhaust sensor temporarily deviates from normal due to the influence of adsorbable species on the sensor element. It is assumed that the adsorbable species becomes chemically adsorbed to the sensor element when the exhaust sensor temperature lowers after an internal combustion engine stop. The deviation of the exhaust sensor output due to the influence of the adsorbable species increases with an increase in the amount of adsorbable species adsorption.

The applicant of the present invention has found that the amount of adsorbable species adsorption to the exhaust sensor greatly depends on the exhaust sensor temperature and exhaust gas temperature at the exhaust sensor prevailing after an internal combustion engine stop. More specifically, it is found that if the exhaust sensor temperature lowers to reach a temperature region in which the adsorbable species may become chemically adsorbed (hereinafter referred to as the "absorption temperature region") before the exhaust path temperature sufficiently lowers, a large amount of adsorbable species readily becomes adsorbed.

According to the system disclosed by Japanese Patent Laid-open No. Hei 4-359142, the oxygen sensor is continuously heated for a period of approximately 5 seconds

after an internal combustion engine stop. That is, the system has a function for delaying the temperature of the exhaust sensor (oxygen sensor) lowering into the adsorption temperature region while the process for lowering the exhaust path temperature is in progress.

However, the above-mentioned conventional system stops to heat the oxygen sensor before the exhaust path temperature sufficiently lowers. More specifically, the exhaust path temperature does not significantly lower during the 5 second in which the above conventional system continuously heats the oxygen sensor. Therefore, the above conventional system cannot decrease the amount of adsorbable species adsorption. Consequently, the above conventional system cannot restrain the exhaust sensor output from deviating from normal under the influence of the adsorbable species.

Disclosure of Invention

The present invention has been made to solve the above problems and provides an exhaust sensor control system that is capable of properly detecting the status of an exhaust gas immediately after internal combustion engine startup while minimizing the influence of exhaust sensor output deviation, which is caused by an adsorbable species.

The above object is achieved by an exhaust sensor control system according to a first aspect of the present

invention. The controller controls an exhaust sensor mounted in an exhaust path of an internal combustion engine. The exhaust sensor includes a sensor element for generating an output in accordance with the status of an exhaust gas and a heater for heating the sensor element. The exhaust sensor control system includes a heater control unit for continuing power supply control over the heater until the exhaust gas temperature at the exhaust sensor drops below 80°C after the internal combustion engine is stopped.

In a first aspect of the present invention, power supply control is continued over a heater of an exhaust sensor until the exhaust gas temperature at the exhaust sensor drops below 80°C. This makes it possible to prevent the temperature of an element of the sensor from lowering to reach the adsorption temperature region. As a result, the present invention effectively restrains the exhaust sensor output from deviating from normal under the influence of the adsorbable species by reducing the amount of adsorbable species that becomes adsorbed to the exhaust sensor after an internal combustion engine stop.

In a second aspect of the present invention, the exhaust sensor according to the first aspect of the present invention may further include an element temperature acquisition unit for acquiring the temperature of the sensor element. The heater control unit includes an after-stop power supply control unit for controlling the heater with

time after the internal combustion engine stop, and check, in accordance with the estimated exhaust path temperature and determined elapsed time, whether the exhaust path temperature is below 80°C. As a result, the present invention can continue heating the sensor element for an appropriate period of time without directly detecting the exhaust path temperature.

The above object is also achieved by an exhaust sensor control system according to a fourth aspect of the present invention. The controller controls an exhaust sensor mounted in an exhaust path of an internal combustion engine. The exhaust sensor includes a sensor element for generating an output in accordance with the status of an exhaust gas and a heater for heating the sensor element. The exhaust sensor control system includes a recovery value counting unit for counting the elapsed time or the cumulative intake air amount after internal combustion engine startup as a characteristics recovery value. A heater control unit is provided for controlling the heater with a recovery target temperature, which is higher than a normal target temperature, set as a target temperature for the sensor element until the characteristics recovery value reaches a recovery determination value. A cumulative lean time counting unit is also provided for counting, after internal combustion engine startup, the cumulative length of time during which the air-fuel ratio is lean. Further, a

during which the sensor element is maintained at a high temperature in accordance with the time required for adsorbable species desorption.

The above object is also achieved by an exhaust sensor control system according to a fifth aspect of the present invention. The controller controls an exhaust sensor mounted in an exhaust path of an internal combustion engine. The exhaust sensor includes a sensor element for generating an output in accordance with the status of an exhaust gas and a heater for heating the sensor element. The exhaust sensor control system includes a recovery value counting unit for counting the elapsed time or the cumulative intake air amount after internal combustion engine startup as a characteristics recovery value. A heater control unit is provided for controlling the heater with a recovery target temperature, which is higher than a normal target temperature, set as a target temperature for the sensor element until the characteristics recovery value reaches a recovery determination value. A stop period counting unit is also provided for counting the stop period during which the internal combustion engine is stopped. Further, a determination value correction unit is provided for decreasing the characteristics recovery value or increasing the recovery determination value with an increase in the stop period during which the internal combustion engine is stopped.

control system according to a sixth aspect of the present invention. The controller controls an exhaust sensor mounted in an exhaust path of an internal combustion engine. The exhaust sensor includes a sensor element for generating an output in accordance with the status of an exhaust gas and a heater for heating the sensor element. The exhaust sensor control system includes a cumulative lean time counting unit for counting, after internal combustion engine startup, the cumulative length of time during which the air-fuel ratio is lean. The exhaust sensor control system also includes a heater control unit for controlling the heater with a recovery target temperature, which is higher than a normal target temperature, set as a target temperature for the sensor element until the cumulative length of time reaches a recovery determination value.

In a sixth aspect of the present invention, the early desorption of the adsorbable species can be promoted by exercising control to maintain the sensor element at a high temperature until the cumulative time during which the air-fuel ratio is lean reaches the recovery determination value after internal combustion engine startup. Since adsorbable species desorption is promoted when the air-fuel ratio is lean, it can be concluded that adsorbable species desorption is completed when the cumulative lean time reaches the recovery determination value. As a result, when it is concluded that adsorbable species desorption is

completed after internal combustion engine startup, the present invention can properly terminate a high-temperature control process for the exhaust sensor.

In a seventh aspect of the present invention, the exhaust sensor control system according to the sixth aspect of the present invention may further includes a recovery value counting unit for counting the elapsed time or the cumulative intake air amount after internal combustion engine startup as a characteristics recovery value. The controller also includes a determination value correction unit for increasing the cumulative length of time or decreasing the recovery determination value with an increase in the characteristics recovery value.

A seventh aspect of the present invention ensures that the time required for the cumulative lean time to reach the recovery determination value decreases with an increase in the elapsed time or the cumulative intake air amount after internal combustion engine startup (characteristics recovery value). In other words, it is possible to reduce the period of time during which control is exercised to maintain the sensor element at a high temperature. Adsorbable species desorption progresses with an increase in the characteristics recovery value no matter whether the air-fuel ratio is lean. The present invention makes it possible to take the progress of adsorbable species desorption into consideration and accurately minimize the

time during which high-temperature control is exercised over the exhaust sensor.

The above object is also achieved by an exhaust sensor control system according to a ninth aspect of the present invention. The controller controls an exhaust sensor mounted in an exhaust path of an internal combustion engine. The exhaust sensor includes a sensor element for generating an output in accordance with the status of an exhaust gas and a heater for heating the sensor element. The exhaust sensor control system includes an element temperature acquisition unit for acquiring the temperature of the sensor element. The controller also includes a desorption progress value counting unit for counting the elapsed time or the cumulative intake air amount after the temperature of the sensor element reaches the desorption temperature of an adsorbable species adsorbed by the sensor element as a desorption progress value. An output correction unit is provided for correcting the output of the exhaust sensor in accordance with a sensor output correction value. Further, a correction value calculation unit is provided for decreasing the sensor output correction value with an increase in the desorption progress value.

In a ninth aspect of the present invention, it is possible to count the elapsed time or the cumulative intake air amount after the temperature of the sensor element reaches the adsorbable species desorption temperature as

to a normal temperature. During such an element temperature drop, the adsorbable species becomes adsorbed to the sensor element 14. However, the exhaust gas temperature and humidity at the sensor element 14 are no longer high. Therefore, a small amount of adsorbable species becomes adsorbed. If the amount of adsorbable species adsorption is small, the influence of the adsorbable species immediately disappears after a subsequent internal combustion engine restart. As a result, the controller according to the present embodiment minimizes the influence of oxygen sensor output deviation, which is caused by the adsorbable species, and begins to properly detect the exhaust gas status immediately after internal combustion engine startup.

[Example of a Modified Process Performed by the First Embodiment]

A modified process performed by the first embodiment will now be described. The adsorbable species, which causes the oxygen sensor output to suffer rich displacement, becomes chemically adsorbed to the oxygen sensor 10. In addition, the carbon content of the exhaust gas may also become adsorbed to the oxygen sensor 10. The carbon content can be burned off by heating the sensor element 14 to a temperature, for instance, of approximately 700°C.

As described earlier, the controller according to the present embodiment continues to control the heater 24 until the exhaust pipe path temperature drops below 80°C after an

CLAIMS

1. An exhaust sensor control system for an exhaust sensor mounted in an exhaust path of an internal combustion engine, wherein said exhaust sensor includes a sensor element for generating an output in accordance with the status of an exhaust gas and a heater for heating said sensor element, the exhaust sensor control system comprising:

heater control means for continuing power supply control over said heater until the exhaust gas temperature at the exhaust sensor drops below 80°C after the internal combustion engine is stopped.

2. The exhaust sensor control system according to claim 1, further comprising element temperature acquisition means for acquiring the temperature of said sensor element, wherein said heater control means includes after-stop power supply control means for controlling said heater with a predetermined temperature between 300°C and 500°C set as a target temperature for said sensor element after the internal combustion engine is stopped.

3. The exhaust sensor control system according to claim 1 or 2, wherein said heater control means comprises

stop moment exhaust temperature estimation means, which estimates the exhaust path temperature at a stop moment

of the internal combustion engine, and

temperature condition determination means, which determines whether the exhaust path temperature is below 80°C based on the exhaust path temperature at said stop moment and the elapsed time after said internal combustion engine is stopped.

4. An exhaust sensor control system for an exhaust sensor mounted in an exhaust path of an internal combustion engine, wherein said exhaust sensor includes a sensor element for generating an output in accordance with the status of an exhaust gas and a heater for heating said sensor element, the exhaust sensor control system comprising:

recovery value counting means for counting the elapsed time or the cumulative intake air amount after internal combustion engine startup as a characteristics recovery value;

heater control means for controlling said heater with a recovery target temperature, which is higher than a normal target temperature, set as a target temperature for said sensor element until said characteristics recovery value reaches a recovery determination value;

cumulative lean time counting means for counting, after internal combustion engine startup, the cumulative length of time during which the air-fuel ratio is lean; and

determination value correction means for increasing

said characteristics recovery value or decreasing said recovery determination value with an increase in said cumulative length of time.

5. An exhaust sensor control system for an exhaust sensor mounted in an exhaust path of an internal combustion engine, wherein said exhaust sensor includes a sensor element for generating an output in accordance with the status of an exhaust gas and a heater for heating said sensor element, the exhaust sensor control system comprising:

recovery value counting means for counting the elapsed time or the cumulative intake air amount after internal combustion engine startup as a characteristics recovery value;

heater control means for controlling said heater with a recovery target temperature, which is higher than a normal target temperature, set as a target temperature for said sensor element until said characteristics recovery value reaches a recovery determination value;

stop period counting means for counting stop period during which the internal combustion engine is stopped; and

determination value correction means for decreasing said characteristics recovery value or increasing said recovery determination value with an increase in the stop period during which the internal combustion engine is stopped.

6. An exhaust sensor control system for an exhaust sensor mounted in an exhaust path of an internal combustion engine, wherein said exhaust sensor includes a sensor element for generating an output in accordance with the status of an exhaust gas and a heater for heating said sensor element, the exhaust sensor control system comprising:

cumulative lean time counting means for counting, after internal combustion engine startup, the cumulative length of time during which the air-fuel ratio is lean; and

heater control means for controlling said heater with a recovery target temperature, which is higher than a normal target temperature, set as a target temperature for said sensor element until said cumulative length of time reaches a recovery determination value.

7. The exhaust sensor control system according to claim 6, further comprising:

recovery value counting means for counting the elapsed time or the cumulative intake air amount after internal combustion engine startup as a characteristics recovery value; and

determination value correction means for increasing said cumulative length of time or decreasing said recovery determination value with an increase in said characteristics recovery value.

8. The exhaust sensor control system according to claim 6 or 7, further comprising:

stop period counting means for counting stop period during which the internal combustion engine is stopped; and

determination value correction means for decreasing said cumulative length of time or increasing said recovery determination value with an increase in the stop period during which the internal combustion engine is stopped.

9. An exhaust sensor control system for an exhaust sensor mounted in an exhaust path of an internal combustion engine, wherein said exhaust sensor includes a sensor element for generating an output in accordance with the status of an exhaust gas and a heater for heating said sensor element, the exhaust sensor control system comprising:

element temperature acquisition means for acquiring the temperature of said sensor element;

desorption progress value counting means for counting the elapsed time or the cumulative intake air amount after the temperature of said sensor element reaches the desorption temperature of an adsorbable species adsorbed by the sensor element as a desorption progress value;

output correction means for correcting the output of said exhaust sensor in accordance with a sensor output correction value; and

correction value calculation means for decreasing said sensor output correction value with an increase in said desorption progress value.

10. The exhaust sensor control system according to claim 9, further comprising stop period counting means for counting the stop period during which the internal combustion engine is stopped, wherein said correction value calculation means includes initial value setup means, which increases the initial value for said sensor output correction value with an increase in said stop period.